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Digital Mapping, Charting, and Geodesy Analysis Program (DMAP)

Technical Review of Tactical Ocean Data—Levels 3 (TOD3)

JOHN L. BRECKENRIDGE
HILLARY C. MESICK
KEVIN B. SHAW

Mapping, Charting, and Geodesy Branch
Marine Geosciences Division

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John L. Breckenridge, Hillary C. Mesick, and Kevin B. Shaw

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14. ABSTRACT

The Tactical Ocean Data—Level 3 (TOD3) Performance Specification offers a definition of the content and format for this emerging standard Mapping, Charting, & Geodesy (MC&G) product. As a vector-type product, TOD3 is designed to portray seafloor configuration, particularly in shallow water areas between 20 meters and 200 meters, along with non-submarine contacts data in a manner suitable for supporting subsurface navigation. TOD3 design is based upon the need for using it in conjunction with the Digital Nautical Chart (DNC) data for providing complete navigation information. This report presents a technical review of the TOD3 as evaluated by the Naval Digital MC&G Analysis Program at Stennis Space Center.

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Technical Review of Tactical Ocean Data – Level 3 (TOD3)
DMAP Technical Review

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DMAP Technical Review

1.0 Background

The Tactical Ocean Data – Level 3 (TOD3) Performance Specification offers a definition of the content and format for this emerging standard Mapping, Charting & Geodesy (MC&G) product. As a vector-type product, TOD3 is designed to portray seafloor configuration, particularly in shallow water areas between 20 meters and 200 meters, along with non-submarine contacts data in a manner suitable for supporting subsurface navigation. TOD3 design is based upon the need for using it in conjunction with the Digital Nautical Chart (DNC) data for providing complete navigation information. This report presents a technical review of the TOD3 as evaluated by the Naval Digital MC&G Analysis Program (DMAP) at Stennis Space Center.

The following sections offer areas of discussion relevant to the specific data content and the correctness of information contained in the TOD3 Specification. It also describes modifications and additions that are recommended to improve both the readability and the functionality of the TOD3 Specification. Since TOD3 depends on the data content and format specifications of the TOD2 and the Digital Nautical Chart (DNC) standard products, the following table is offered to compare TOD3 information content to these products.

1.1 Table 1. TOD3 Comparison to TOD2 and DNC

Product	Intended Use, Area Extent and Data Sources	Format	Source and # of Charts	Compilation Scale	Depth Area Features	Depth Contours Collected	Depth Contours Portrayed
TOD3	Detailed classified vector-based data portraying seafloor configuration in shallow water areas between 20 meters and 200 meters water depth. Includes Non-submarine contacts data in format suitable for computerized subsurface navigation.	Vector	TOD2 and Non-submarine contacts data	Variable range from 1:50,000 to 1:1,000,000	Collected from 20 meters to 200 meters.	5 meter intervals between 20 meters and 200 meters	20 meter contour, 25 meter contour and every 25 meters thereafter to 200 meters to be attributed as index contours; all others are attributed intermediate
TOD2	Detailed classified depth information to permit the safe underwater navigation of submarines. Hydrographic sources: NAVOCEANO Ocean Survey Program data.	Vector	Bathymetric Navigation Planning Chart >200m (675 charts)	Based on Hardcopy BNPC; variable from 1:190,881 to 1:547,646	Collected every 200 meters at depths from 0 to 1000 meters and every 600 meters thereafter.	5 meter intervals between 20 meters and 200 meters	Contours at 20 meters, 50 meters and every 25 meters thereafter will be designated as index contours; other contours at 5-meter intervals will be intermediate contours.
DNC	Portrays selected maritime significant	Vector	Based on the feature	Variable ranging from	Variable based on	Variable based on	Variable based on individual chart

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	physical features in a format suitable for computerized marine navigation		content of the hardcopy Harbor, Approach, Coastal and General charts.	1:50,000 to 1:500,000	individual chart specifications.	individual chart specifications.	specifications.

1.2 Intended Uses

TOD Level 3 is expected to support all forms of computerized subsurface navigation. It is intended to store Non-submarine contacts data in conjunction with the DNC. Since the product is designed to provide water depth contour information as previously stated within areas between 20-meters and 100-meters, one might assume vessels with a shallow draft of less than 20-meters would be expected to utilize this information. This would include the possibility of various small craft, (e.g., Swimmer Delivery Vehicles (SDV)), since the stated purpose is to support "computerized subsurface navigation".

1.3 Editorial Comments and Additions:

1.3.1 Pg3, Sec. 3.2.2 Absolute Vertical Accuracy: No AVA is given because all data is at or below MSL. However, AVA can also apply to the accuracy of features below MSL and should be included in this spec. Vertical column data (i.e., sound speed, salinity, temperature, or visibility) can all have a vertical accuracy statement.

1.3.2 Pg13, Sec. 3.16.2.2: Description indicates "data in waters shallower that 200 Meters". It should also indicate that values fewer than 20 Meters are not represented in the product.

1.3.3 Pg18, Appendix B – TOD3 excludes the Earth Cover Integer Value Description Table found in TOD2. Although this feature is not contained within the DNC Specification, it could be valuable to text placement and color matching when attempting to duplicate cartographic features on a digital display device (i.e., labeling based on HIS value).

1.3.4 Pg18, Appendix B – TOD3 excludes the "symbol.rat" description from the Earth Cover Text Feature Table in the Header description. This should be added for consistency with TOD2.

1.3.5 Pg21, Appendix B- TOD3 excludes the descriptor for Row Identifier 5 where the table1_key= symbol.rat_id and table2=symbol.rat. This should be added for consistency with TOD2.

1.3.6 Pg22, Appendix B – For consistency with the TOD2 Specification, the 'description' field for table soundp.pft, and attribute snd within the Hydrographic Integer Value Description Table should read "No Bottom".

1.3.7 Pg22, Appendix B – For consistency with the TOD2 Specification, the 'description' field for table soundp.pft and attribute svc and value 5 within the Hydrographic Integer Value Description Table should read "Other Calibration".

1.3.8 Pg24, Appendix B- For consistency with the TOD2 Specification, the 'description' field for Soundings Point Feature Table, svc (sounding velocity) and value 5 should read "Other Calibration".

1.3.9 Pg28, Appendix B – The Specification document does not define the Table Name following the Table Description. It should read "Table Name: fcs".

1.3.10 Pg29, Appendix B – The TOD3 Specification contains an extra value (re: 4 contactp.pft na4 UNK Unknown). This value is not present in the TOD2 Spec. and there is no explanation given for its addition.

1.3.11 Pg30, Appendix B – Value contactp.pft tng is shown in the TOD2 Spec., but is not present in the TOD3 Spec.

2.0 Comments on Draft Specification

The following sections offer comments concerning specific technical areas addressed in the Draft Specification for TOD3.

2.1 Hydrographic Datum

A Hydrographic Datum is the vertical reference level from which depths are measured. For shallow waters near coastal areas the convention in the past has been to reference the depth of water to Mean-Low-Low-Water (MLLW). This reference datum was obtained from shore based tidal observation stations with sufficient observations over time to make an accurate direct measurement of MLLW or adequate observations to model the observed tides for an estimate of MLLW from information obtained from other tidal stations located in the survey region. The purpose of the use of MLLW as the tidal datum was to furnish a built in safety factor, in that on the average within normal tidal variation, you could be assured of depths at least as great as that shown on the chart.

Deep-water surveys conducted far off shore were assumed to be relatively free from the effects of coastal tidal influence. Thus, a simple tidal model could be used for sounding corrections or no tidal correction would be applied. In this case the sounding datum would be stated as Mean Sea Level (MSL)

Section *3.3.2 Vertical datum* of the draft TOD3 specification states that the vertical reference datum for TOD3 will be MSL. While MSL is perhaps the best choice for offshore deep waters with little tidal variations it is not a good choice for near shore hydrographic data. Most coastal charts currently produced use MLLW as the vertical datum. In areas of high tidal range near shore, which could well be in the 20m. – 200m. depth range of TOD3, the use of MSL vice MLLW could lead to errors of interpretation. This would be especially true for users who are familiar with charts based on MLLW. A failure to take into account the difference between MSL and MLLW as the chart datum could have significant impact on the establishment of adequate vessel clearance during operation.

If MSL is used as the chart datum it is imperative that it be used with an ECDIS-N system that is fully capable of displaying the hydrographic information corrected for predicted tides both in real time and for times projected into the future. This is essential for safety of operation in shallow coastal waters with large tidal ranges.

2.2 Cartographic Scale and Positional Accuracy

Historically the rule of thumb for positional accuracy for most cartographic features was 1 millimeter at the scale of the chart (a pencil mark). For a 1:50k chart that would mean the positional accuracy of displayed features would be 50 meters, 1:100k 100 meters accuracy, 1:500k 500 meters, and so forth. The *TOD3 specification section 3.2.1* states a horizontal accuracy of 250 meters. Using the rule of thumb, it would imply a suitable chart scale would be 1:250k.

However *section 3.14.2 Compilation scale* states 1:50k – 1: 100k. Compilation scale while used differently for cartographic scale should in general be in the same "neck of the woods" as the

cartographic scale. In consulting the attribute values in Non-Submarine Contacts, BD180 Wreck, for the Position Evaluation Attribute, **pev**, five accuracy values are given:

1) Accuracy less than 1 mile
2) Greater than 1 nautical mile and less than or equal to 3 nautical miles
3) Greater than 3 nautical mile and less than or equal to 5 nautical miles
4) Greater than 5 nautical mile and less than or equal to 10 nautical miles
5) Accuracy uncertain

These positional accuracy values for the **pev** attribute are far removed from what is required for display on a chart at the 1:250k scale and larger.

From reading the specification, it is unclear what the user can expect in the way of positional accuracy of the features. And in general, the specification implies that a wide range of positional accuracy will be used in the production of the product.

To combine high-resolution bathymetry with low accuracy historical non-submarine contact locations could be misleading to the user. It is suggested that if these two classes of positional accuracy are provided to the user for simultaneous display, that the features that use the **pev** attribute be provided with a circular area symbol, which would indicate that the feature may be located anywhere within the circular region. This would hopefully prevent the user from misinterpreting the positional accuracy of he charted feature. For comparison purposes the IHO hydrographic survey standards are included in Table 1 for reference [1].

Table 2
Summary of Minimum Standards for Hydrographic Surveys

ORDER	Special	1	2	3
Examples of Typical Areas	Harbours, berthing areas, and associated critical channels with minimum underkeel clearances	Harbours, harbour approach channels, recommended tracks and some coastal areas with depths up to 100 m	Areas not described in Special Order and Order 1, or areas up to 200 m water depth	Offshore areas not described in Special Order, and Orders 1 and 2
Horizontal Accuracy (95% Confidence Level)	2 m	5 m + 5% of depth	20 m + 5% of depth	150 m + 5% of depth
Depth Accuracy for Reduced Depths (95% Confidence Level) (1)	a = 0.25 m b = 0.0075	a = 0.5 m b = 0.013	a = 1.0 m b = 0.023	Same as Order 2
100% Bottom Search	Compulsory (2)	Required in selected areas (2)	May be required in selected areas	Not applicable
System Detection Capability	Cubic features > 1 m	Cubic features > 2 m in depths up to 40 m; 10% of depth beyond 40 m (3)	Same as Order 1	Not applicable
Maximum Line Spacing (4)	Not applicable, as 100% search compulsory	3 x average depth or 25 m, whichever is greater	3-4 x average depth or 200 m, whichever is greater	4 x average depth

Table 3 - Legend

(1) To calculate the error limits for depth accuracy the corresponding values of a and b listed in Table 1 have to be introduced into the formula

$$\pm\sqrt{[a^2+(b*d)^2]}$$

with

- a constant depth error, i.e. the sum of all constant errors
- b*d depth dependent error, i.e. the sum of all depth dependent errors
- b factor of depth dependent error
- d depth

(2) For safety of navigation purposes, the use of an accurately specified mechanical sweep to guarantee a minimum safe clearance depth throughout an area may be considered sufficient for Special Order and Order 1 surveys.

(3) The value of 40 m has been chosen considering the maximum expected draught of vessels.

(4) The line spacing can be expanded if procedures for ensuring an adequate sounding density are used (see 3.4.2)

2.3 TOD3 Bathymetric Contours and DNC Contours

The simultaneous display of DNC bathymetric contours and TOD3 contours will confuse the user in areas of overlap. The DNC contours may have been generated from different source material and may have a differing contour interval. Thus, when both sets of contours are displayed in overlay for the same region a confusing presentation will result. It is recommended that techniques be investigated to mask the DNC contours in areas of overlap with the TOD3 contours when both products are in simultaneous usage. Another approach would be to inform the user to only use one set of contours when operating in overlap regions, i.e. turn off the DNC contours when you have TOD3 contours for the region of interest.

2.4 Coordinate System and Numerical Representation

The TOD3 draft specification calls for the representation of geographical coordinates in floating-point format. The document does not specify whether single or double precision floating-point representation will be used. The following discussion is based on the assumption that single precision floating-point representation will be used.

Single precision floating point representation provides seven significant digits of precision. An illustration of this effect is indicated by the following calculation performed with single precision float point numbers:

90 + .000001 = 90
90 + .000002 = 90
90 + .000004 = 90.00001
90 + .000009 = 90.00001

Similar results were had with other numeric ranges.

As illustrated floating-point arithmetic is subject to round-off errors. Since in general with single precision float point you only have seven significant digits to work with, the spatial resolution of geographic coordinates will vary dependent on where in the world the coordinates specify.

You can see that the resolution depends on the overall magnitude of the number.

180.0001	.0001	degrees	resolution	apx.	11.0 meters
18.00001	.00001	degrees	resolution	apx.	1.1 meters
1.800001	.000001	degrees	resolution	apx.	0.11 meters
0.1800001	.0000001	degrees	resolution	apx.	0.011 meters

Thus for longitude, the resolution runs from 11 meters @ 180 degrees down to 1.1 centimeters near 0 degrees

And in a similar fashion for latitude the resolution runs from 1.1 meters @ 90 degrees to 1.1 centimeters when less than one degree removed from the equator.

The TOD3 specification calls for a spatial resolution of .000005 decimal degrees. As discussed above, single precision floating-point variables are not sufficient to maintain this resolution on a global basis. As an alternative, consideration should be given to either double precision floating point or for more storage efficient, 32 bit signed integers that contain the coordinates in micro-degree units. The use of integer representation provides uniform resolution regardless of geographical location. However if the horizontal resolution is to indeed be 250 meters (which doesn't seem adequate for high resolution bathymetry) then .000005 decimal degrees resolution is not required, and single precision floating point would be adequate.

3.0 Possible Data Content Additions to TOD3 Product

Adding data to a MIL-Specification like TOD3 can be an expensive effort. However, the absence of this information can also prove costly in relation to the successfulness of a mission. The following sections address some of the issues involved in adding and/or improving the content of TOD3.

3.1 Value Adding GIDB

Value-adding digital MC&G products has become commonplace practice for military operations. The process of value-adding data can include functions related to 1) adding higher resolution data within specific areas, 2) modifying or adding attribute descriptions for specific data types, and 3) restructuring geometric features to provide relational topology. Geospatially enabled missions often require additional detail and/or higher resolution information than the spatial features provided in a standard product database. TOD3 will be no exception to this rule. The structuring of value added features is usually accomplished as a separate add-on database developed within the user interface of a commercial Geographic Information System (GIS). This means that data is stored in a vendor GIS format (e.g., ESRI Shape file) rather than within the specific product format (e.g., TOD3/VPF). Since value-adding data fields for the TOD3 Specification could enhance the tri-services ability to use this product, NRL recommends that further investigations be conducted into the concept of value adding standard products. One potentially beneficial approach to this task might include adding a "ValueAdd" field to the product specification, while another viewpoint would support adding a totally new product specification that allows the user to build a supplemental MC&G product. In the case of adding a data

field such as "ValueAdd" to the specification, any new data would be directly associated with each of the five data coverages. This would allow additional data to be specified in a dynamic way by the end user, but would insure that it follows a specified format and could be readily shared with any other product users.

Some current research that relates to these efforts would be NRL's Precision Underwater Mapping (PUMA) under the direction of SPAWAR PMW 150. Part of the current PUMA tasking requires that high-resolution bathymetry data be able to be added to supplement bathymetry stored within NAVOCEANO's Digital Bathymetric Data Base Variable (DBDBV) dataset. Issues addressed in this effort include the interpolation (i.e., feathering) of data at the merge boundaries, and the modeling of effects on imagery resolution and feature content as a result of adding higher resolution imagery subsets to the overall data holdings. These efforts may produce results that could be valuable to any further investigation of this issue for TOD3. As well, any further investigation by DMAP into the issue of value adding standard NIMA products could also benefit PUMA and other ongoing programs requiring the storage of supplemental geospatial information.

3.2 Meta Data Inclusion

The use of Metadata continues to play a significant role in the implementation and use of digital MC&G data products. NIMA has recently noted a trend toward moving away from the standard digital product formats and moving toward the implementation of open industry standards, (e.g., OpenGIS, ISO). The FGDC Web page for Geospatial Metadata states that "Executive Order 12906, "Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure," was signed on April 11, 1994, by President William Clinton. Section 3, Development of a National Geospatial Data Clearinghouse, paragraph (b) states: "Standardized Documentation of Data, ... each agency shall document all new geospatial data it collects or produces, either directly or indirectly, using the standard under development by the FGDC, and make that standardized documentation electronically accessible to the Clearinghouse network." This standard is the data documentation standard referenced in the executive order." By this order, government is currently mandated to include all public release geospatial data in the National Spatial Data Infrastructure (NSDI), although the Defense industry often takes its "opt out" option to this requirement.

The inclusion of the FGDC Metadata Standard as part of the TOD3 Specification would insure an adequate submission of descriptive information concerning data distributed in this product format. In the case of value-adding data, the Metadata Standard could be used to insure that new data added to any existing TOD3 product would be adequately documented with reference to its creation date, life expectancy, originator and other crucial information.

3.3 Currents and Tides

Changes in currents and tides can have a great impact upon small sized vessels. The more dynamic the change, the more significant the effect these parameters have on operations within the Littoral regime. The addition of currents and tidal datum to TOD3 could provide an improved representation of shallow water areas of approximately 20 to 30 meters. Although the TOD3 product coverage represents areas with depths ranging from 20 meters to 200 meters, tidal data for areas extending shoreward from the 20-meter curve to approximately 30+meters would significantly increase the products ability to communicate the impacts that these dynamic conditions have on naval missions. Support vessels operating in these areas (i.e., submarine assistance to SDV) could greatly benefit in knowing the current and tidal conditions for seasonal averages, as well as during specific mission timeframes. This would require that TOD3 also store dynamic link references to pre-approved sources for temporal update of these conditions.

NRL recommends the addition of data definitions for storing currents and tidal information fields, including fields for dynamic links that can be accessed to provide near real-time update of these data. The following section details the format for such an addition as a *Hydrographic Feature* entity as reference in the DIGEST Part 4 FACC [5].

Tidal/Currents Feature Table

Thematic Layer:	Hydrography
Coverage Name:	hyd
Feature Table Description:	Hydrography Tidal/Currents Point Feature Table
Thematic Index ID Number:	3

```
{Header length}L;
Hydrography Tidal/Currents Feature Table;-;
id=I, 1, P, Row Identifier,-;-;-;:
fclass=T, 8, U, Feature Class Name, char.vdt,-,-,-,:
fcode=T,5,N,FACC Feature Code, char.vdt,-;-;-,:
tile_id=S, 1, N, Tile Reference ID, -, till_id.pti,-,:
end_id=I, 1, N, Entity Node Primitive ID,-,endl_id.pti,-,:;
type
```

Column	Description	Value	Value Meaning	Applicable f_code for Each Attribute Value
Id	Row Identifier		Sequential beginning with 1	
fclass	Feature Class Name			
		BF – Hydrography – Tide and Current Information		
fcode	FACC Feature Code			
		BG010	US-Current Flow UK-Current Flow/Tidal Stream Direction	
		BG011	Tideway	
		BG012	Water Turbulence	
		BG020	Tide Guage	
		BG030	US-Tide Data Point UK-Tidal Stream Observation Station	
		BG040	US-Current Diagram UK-Tidal Stream Diagram	
		TBD		
type	Feature Type			
		P	Point/Node Feature	TBD
		L	Line Feature	TBD
		A	Area	
descr	Description			
		Tides/Currents Point Feature		

Tides/Currents Line Feature
Tides/Currents Area Feature

3.4 Seasonal Water Clarity

Visibility, as defined by the Bowditch [2] is "the extreme horizontal distance which prominent objects can be seen and identified by the unaided eye." Visibility in water is related more as a function of water clarity and the amount of particulate matter suspended within the water column. Water clarity can be measured in both horizontal and vertical dimensions and can vary greatly due to seasonal phenomena (i.e., rain, wind, pollution etc.). Water clarity can also be measured as both direct and in-direct functions of water depth, or simply as an independent variable of water quality. Seasonal water clarity data can be collected and stored in various methods, the most common of which are through 1) satellite data (e.g., SeaWIFS, GOES, LANDSAT, etc.) measuring the amount of spectral reflectivity, and/or 2) field instruments, both analog and digital, designed to measure clarity as a function of turbidity or sediment distribution.

Visual clarity has been traditionally measured in lakes and shallow water areas using an analog device called a Secchi disc (i.e., black disc). Suspended on a rope, the painted disc is lowered through the water until it becomes invisible to the naked eye, at which point the visible water depth (i.e., secchi depth) is determined by the amount of rope deployed [3]. In this case, water clarity is a direct function of depth. In other instances, digital spectrometers measuring particulate count as a function of light reflectivity may be used to determine the volume of suspended particles within a water sample or simply the color [4] of the water in relation to water clarity. In any case, one way of making this data valuable to a specific application is to periodically measure and store these values over time. Statistical averages and anomalies then become available to implement as variables in tactical decision aides and planning tools for estimating the impact of water clarity on particular missions. In particular, water clarity information can be of great value to amphibious operations and shallow water force deployment. Such is the case with shallow water submariner activities utilizing the Swimmer Delivery Vehicle (SDV).

Currently, the storage of seasonal water clarity data is not directly supported within TOD3. However, value-adding TOD3 with this data could be extremely beneficial to operational naval forces. Adding additional features to a data product can be accomplished by either adding new feature definitions (i.e., coverages or individual entities/attributes) to the data specification or by simply modifying current feature definitions. In examining the TOD3 data layers, the addition of new feature coverages (i.e., *Water Quality or Oceanographic)* can be viewed as a way of providing the most flexibility for designing the data specification in a manner that's directly relevant to the specific requirements for individual data items. However, that does open the door for unchecked expansion of the data specification every time a new feature is identified. This method also requires the most time and effort and carries a high risk of introducing unnecessary redundancy in the specification. Therefore, in this instance, modifying existing data feature definitions is viewed as the most beneficial approach to value adding the TOD3.

Seasonal water quality data most directly relates to either the *Hydrography* or *Survey Information* coverages. As noted, water clarity can be considered dependent upon water depth, and might be represented as a point, line or area features of value type *Depth* in the *Hydrography* coverage. In doing so, an added *Hydrography Feature Class Attribute Table* value *descr=waterqual* might be sufficient to represent this data. However, this could severely limit the product's ability to represent this data as a function of any other parameter (i.e., turbidity). Since seasonal data quality more directly reflects only one of potentially many types of surveyed oceanographic parameters, it becomes apparent that the best solution may be to expand the definition of the *Survey Information*

coverage the addition of a *Survey Point Feature Table*. The following section presents a proposed addition to MIL-PRF-89049/I3 APPENDIX B:

Survey Point Feature Table

Thematic Layer:	Survey Information
Coverage Name:	sur
Feature Table Description:	Survey Point Feature Table
Thematic Index ID Number:	3

```
{Header length}L;
Survey Point Feature Table;-;
id=I, 1, P, Row Identifier,-;-;-;:
fclass=T, 8, U, Feature Class Name, char.vdt,-,-,-,:
fcode=T,5,N,FACC Feature Code, char.vdt,-;-;-,:
tile_id=S, 1, N, Tile Reference ID, -, till_id.pti,-,:
end_id=I, 1, N, Entity Node Primitive ID,-,endl_id.pti,-,:;
type
```

Column	Description	Value	Value Meaning	Applicable f_code for Each Attribute Value
Id	Row Identifier		Sequential beginning with 1	
fclass	Feature Class Name	TBD		
fcode	FACC Feature Code	TBD		
type	Feature Type			
		P	Point/Node Feature	TBD
		L	Line Feature	TBD
		A	Area	
descr	Description			
		Water Clarity Point Feature		
		Water Clarity Line Feature		
		Water Clarity Area Feature		

4.0 TOD3 Features and Attributes:

The TOD3 consists of both features (i.e., geometry/coordinates), plus the attributes needed to describe the feature in relation to the original product requirement. To determine if the feature and attributes adequately represent the data requested in the original requirement, each user requirement would have to be reviewed in comparison to the data content. Since this technical review concentrates upon the TOD3 Specification and not

the requirements, the attributes and feature for the product are being reviewed for basic clarity of definition and logical content.

4.1 Compatibility with VPF Product Family Including DNC and AML:

Compatibility with other products stored in the Vector Product Format (VPF) can be gauged primarily by the TOD3 product's compatibility with the Digital Nautical Chart (DNC). As a Standard data product stored in VPF, DNC provides a structure that supports the storage of features required for computerized navigation. Likewise, TOD3 is designed to provide detailed classified vector-based data portraying seafloor configuration in shallow water areas between 20 meters and 200 meters water depth. It includes Non-submarine contacts data in a format suitable for computerized subsurface navigation. As a VPF-based product, TOD3 stores data compatible with the specifications for TOD2 at variable scales of 1:50,000 to 1:1,000,000. Hydrographic features included in the TOD3 product represent bathymetric contours, soundings and navigation aids. The Non-submarine contacts describe features that are submerged and/or located on the ocean bottom within the horizontal range of the product (i.e., TOD3= 20m to 200m).

5.0 Symbology:

The TOD3 Specification offers no reference to requirements for symbolizing the feature entities identified in this product. It is expected that the standard DoD Specification for Geospatial Symbols for Digital Displays, MIL-PRF-89045, Edition 4 or later. In the case of the recommended addition of features for TOD3 (e.g., water clarity), additional review of the GeoSym 4 Specification may be required to determine if all features relevant to TOD3 are supported. However, preliminary investigation seems to indicate that GeoSym 4 will adequately support the display of TOD3.

6.0 Conclusion:

The TOD3 Specification appears to adequately support the representation of the data content needed to assist in storing non-submarine contacts and other information associated with computerized navigation consistent with geographic areas with associated water depths of between 20 meters and 200 meters. Although this range does not fully support the entire littoral zone, it does adequate support most areas where small to medium size vessels would be operating in support of submerged naval operations. The addition of a *Water Clarity Feature* to the TOD3 would greatly enhance the Warfighter's ability to understand the operational environment portrayed by TOD3.

7.0 Recommendations:

DMAP offers the following recommendations in reference to the TOD3 Specification:

7.1 Value Adding TOD3 Data:

NRL recommends that further investigations be conducted into the concept of value adding TOD3 and other standard products. This could be accomplished by adding a "ValueAdd" field to the specification or by developing a totally separate specification directed toward the storage of supplemental data for DoD Standard Products. Any dynamic data field added to the existing specification would be associated with each of the five data coverages so as to allow direct integration of new data with any data already stored in the product format. The primary format for such a value-added feature would need to be approved by NIMA to insure compatibility with the DNC production line. It could assume the form of both feature/entity descriptions and feature attribute descriptions that complement point; line and area features already stored in each of the TOD3 coverages (i.e., ecr_valueadd, hyd_valueadd, etc.). More examination is needed to determine the overall effects of adding such a dynamic feature to the TOD3 Specification vs. addressing this issue on a broader scale for all DoD Standard products.

7.2 Metadata Inclusion:

The inclusion of the International Standards Organization (ISO) and FGDC Metadata Standard as part of the TOD3 Specification would insure an adequate submission of descriptive information concerning data distributed in this product format. In the case of value-adding data, the Metadata Standards could be used to insure that new data added to any existing TOD3 product would be adequately documented with reference to its creation date, life expectancy, originator and other crucial information.

7.3 Addition of Currents and Tidal Information:

NRL recommends the addition of data feature definitions for storing currents and tidal information; including fields for dynamic links that can be accessed to provide near real-time update of these data.

7.4 Addition of a Water Clarity Feature:

NRL recommends the addition of data features for storing water clarity information fields, including fields for dynamic links that can be accessed to provide near real-time update of these data.

7.5 Editorial Comments and Additions:

7.5.1 Pg3, Sec. 3.2.2 Absolute Vertical Accuracy: No AVA is given because all data is at or below MSL. However, AVA can also apply to the accuracy of features below MSL and should be included in this spec. Vertical column data (i.e., sound speed, salinity, temperature, or visibility) can all have a vertical accuracy statement.

7.5.2 Pg13, Sec. 3.16.2.2: Description indicates "data in waters shallower that 200 Meters". It should also indicate that values fewer than 20 Meters are not represented in the product.

8.0 Acknowledgements:

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9.0 References:

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10.0 Distribution List:

Oceanographer of the Navy
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34th & Mass. Ave., NW
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Library (8)
Stennis Space Center, MS 39522-5004

Commander
SPAWARSYSCOM
4301 Pacific Hwy
San Diego, CA 92110-3127

SPAWARSYSCOM
Attn: Mr. Ed Mozley (5)
4301 Pacific Hwy
San Diego, CA 92110-3127